DEMONSTRATION

Bin-liner physics: getting to grips with capacitance

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and
\[ \frac{V(0, t)}{V(-l, t)} = \frac{4.7 \pm 0.1}{7.9 \pm 0.1}. \]
Substitute into equation (4),
\[ c = (2.85 \pm 0.15) \times 10^8 \text{ m s}^{-1}. \]

**Discussions**

The standing-wave method is suitable for project learning at A-level because it requires neither complicated mathematics nor expensive measuring instruments. Although schools may not have an RSG to generate a 10 MHz radio signal, it is a cheaper alternative to an additional audio SG.

Experiments that require little power* – for example, for the topics of sound and ultrasound, capacitance and inductance, electromagnetic induction and telecommunication by amplitude modulation – can be carried out using either type of SG. Technically, building a U-shaped coaxial pipeline requires some skill and practice. If necessary, the school can seek help from a nearby hardware store.

**Reference**


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*Note, the RSG is not suitable for experiments requiring a large output current. Examples include the generation of mechanical oscillation by a vibration generator and the demonstration of parallel resonance using mini bulbs.*

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**Demodulation**

**Bin-liner physics: getting to grips with capacitance**

Capacitance can be a rather abstract subject to teach, and many students struggle to understand what happens within the fat cylinders that I pass around the class when introducing this topic. To help them visualize the physics I usually build a simple capacitor from two sheets of aluminium foil separated by a single layer of black polythene cut from a bin liner.

Figure 1 shows a typical arrangement of the apparatus. The sheets of aluminium foil that comprise the capacitor plates are 60 × 45 cm. They are placed above and below the polythene dielectric. Crocodile clips connect the plates to the positive and negative terminals of a 5 kV dc supply. As a precaution, earth the lower piece of foil, and connect an extra lead to earth should you need to discharge the upper plate.

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**Figure 4.** A U-junction can be formed by joining two L-junctions with one I-junction.

**Figure 5.** Oscilloscope traces of \( V(0, t) \) and \( V(l, t) \).
The collapsing-can demonstration, often used in teaching the topic of pressure, is usually carried out by generating a cooling effect inside a can [1–4]. This can be achieved by boiling a small amount of water in a can, then capping the vessel before immersing it in water. As cooling occurs, the pressure differential causes the can to crumple.

In the following version of the demonstration, no heating or cooling is required. This demonstration has not previously been described in the literature.

**Method**

A 12 m length of rubber tubing (diameter 1.8 cm) is filled with water and sealed with a clip at one end. The other end of the tube is connected to the mouth of a one gallon (4.5 litre) tin can – which has been filled with water – via a hole in its metallic cap. After ensuring that the column of water is continuous and that there are no air bubbles, the entire set-up is inverted and held by a support (figure 1). The clip end of the tube is then opened. As the water drains away, the can collapses. The demonstration is usually done from a fourth-floor window.

(We recently carried out this demonstration using a 5 m long tube. It also worked, but of course, the can collapsed much more slowly.)

One student holds the can on the support at the fourth-floor window. For additional support another student holds the tube, just below the plastic fitting. On the ground, below the window, a pupil holds the tubing as upright as possible above its clipped end. The clip at the end of the tube is then opened. As the water drains away, the can collapses. The demonstration is usually done from a fourth-floor window.

On health and safety grounds, the power supply must be limited to 10 mA. The supply will therefore trip repeatedly when the polythene breaks down. I also keep my students at least 2 m away from the set-up and I always earth the upper plate before I touch it. The capacitance of the device itself ($\varepsilon_r = 2$, $\varepsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$, $A = 0.25 \text{ m}^2$, $d = 3 \times 10^{-5} \text{ m}$) will be no more than 0.2 $\mu\text{F}$.

- This activity is also described in *Advancing Physics A2*.

**Reference**


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**Demonstration**

Collapsing can aids mastery of pressure laws

The collapsing-can demonstration, often used in teaching the topic of pressure, is usually carried out by generating a cooling effect inside a can [1–4]. This can be achieved by boiling a small amount of water in a can, then capping the vessel before immersing it in water. As cooling occurs, the pressure differential causes the can to crumple.

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(We recently carried out this demonstration using a 5 m long tube. It also worked, but of course, the can collapsed much more slowly.)

One student holds the can on the support at the fourth-floor window. For additional support another student holds the tube, just below the plastic fitting. On the ground, below the window, a pupil holds the tubing as upright as possible above its clipped end. The clip at the end of the tube is then loosened. The rest of the class can gather around the can or stand below the window, since both positions allow a good view. Owing to the flexible nature of the tubing, it is not easy to keep the tube absolutely vertical, but this does not stop the demonstration from working.

The weight of the column of water, extending from the can to the far end of the length of tubing, is heavy enough for the water to flow down under the action of gravity when the clip is loosened. As